A karst study to identify caves was conducted at the installation from 1994 to 1997 along five creeks: Big Creek, Middle Fork Creek, Graham Creek, Little Graham Creek, and Otter Creek (Sheldon 1997). During this inventory, 32 caves with 52 entrances were identified. The cave lengths ranged from approximately 26 ft (7.9 m) to the longest cave length of 1,507 ft (459 m). Nineteen caves were identified along Big Creek, with an average cave length of approximately 162 ft (49.4 m).

The water-level elevations of wells screened in bedrock loosely conform to the configuration of the surface topography. The direction of groundwater flow in bedrock generally is to the west-southwest. The water level elevations measured in the DU Impact Area are variable, ranging from a minimum of 3 ft below the surface in monitoring well (MW)-10 to a maximum of 32 ft (9.8 m) below the surface in MW-09 (refer to Figure 3-2 for well locations) [U.S. Army 2001]. The variability in the depth to groundwater may reflect the occurrence of fractures in bedrock. Table 2-5 provides data for the DU Impact Area groundwater monitoring wells (SEC Donahue, Inc. 1992). Figure 2-8 shows the potentiometric contours based on these data. The wells are too widely spaced to interpret the potentiometric surface or identify preferred flow paths. It appears, however, that in the vicinity of incised surface drainages, the potentiometric surface slopes toward the streams at roughly the same gradient as the surface topography. Therefore, on a local scale, the bedrock groundwater tends to discharge to surface streams (SEC Donahue, Inc. 1992).

Slug and pump tests were completed on 51 wells located south of the firing line screened in the bedrock aquifer. The hydraulic conductivity of the bedrock aquifer computed from slug tests ranges from 0.67×10^{-5} to 2.3×10^{-4} in./sec (1.7×10^{-5} to 5.8×10^{-4} cm/sec) [MWH 2002]. The pumping test results indicate hydraulic conductivities ranging from 0.55×10^{-4} to 2.4×10^{-3} (1.4×10^{-4} cm/sec to 6×10^{-3} cm/sec) [MWH 2002].

Ohio River Alluvial Deposits

The third hydrostratigraphic unit, the Ohio River valley alluvium, does not underlie the site and is significant because it is the only, but is the major, source of groundwater in the region that is available for domestic use (MWH 2002). However, the closest location of this unit is approximately 5 miles (8 km) south of JPG. Because the bedrock groundwater flow direction at JPG generally is to the southwest, and the north-south stream drainages are located west of JPG, it is unlikely that potential contamination present at JPG could reach the Ohio River alluvial aquifers. The southwest groundwater flow direction at JPG is in agreement with the regional groundwater flow direction documented in the USGS Open File Report 90-151 (see Figure 2-9) [Bugliosi 1990].

2.6.2.2 Groundwater use

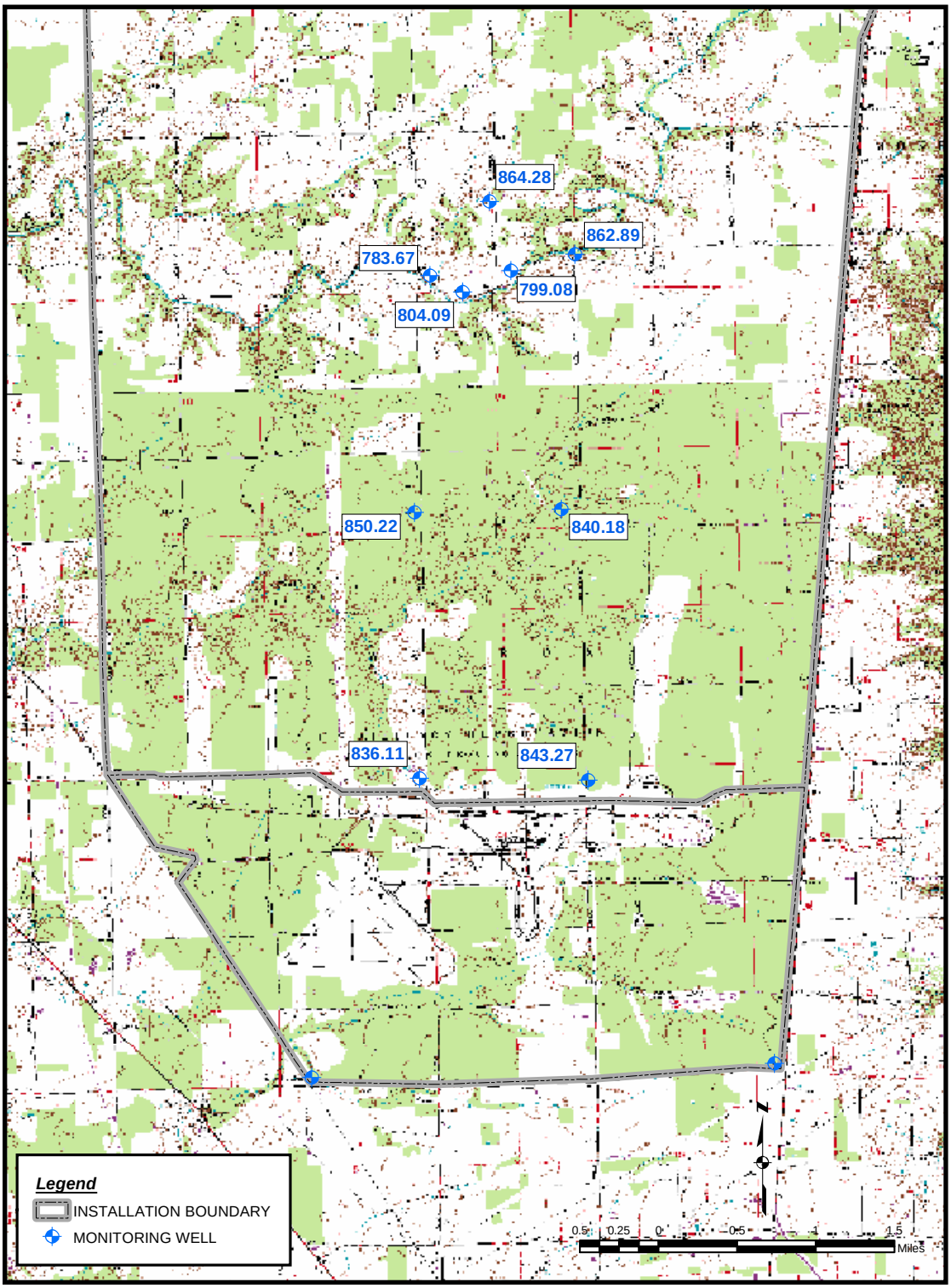
There are no sole source aquifers on or in the vicinity of JPG based on a review of EPA Region 5's sole source aquifer designations (EPA 2002). A sole source aquifer is an aquifer designated by EPA as the sole, or principal, source of drinking water for a given area (i.e., an aquifer that supplies 50% or more of the area), and for which there is no reasonable alternative should the aquifer become contaminated.

The groundwater under JPG generally is of poor quality and is not used for drinking purposes or for other purposes in any significant capacity. The drinking water at JPG is obtained from the City of Madison Municipal Supply Systems and the Canaan Deposits in the Ohio River Valley, approximately 5 miles (8 km) from JPG (MWH 2002).

Table 2-5. DU Impact Area -Groundwater Monitoring Wells

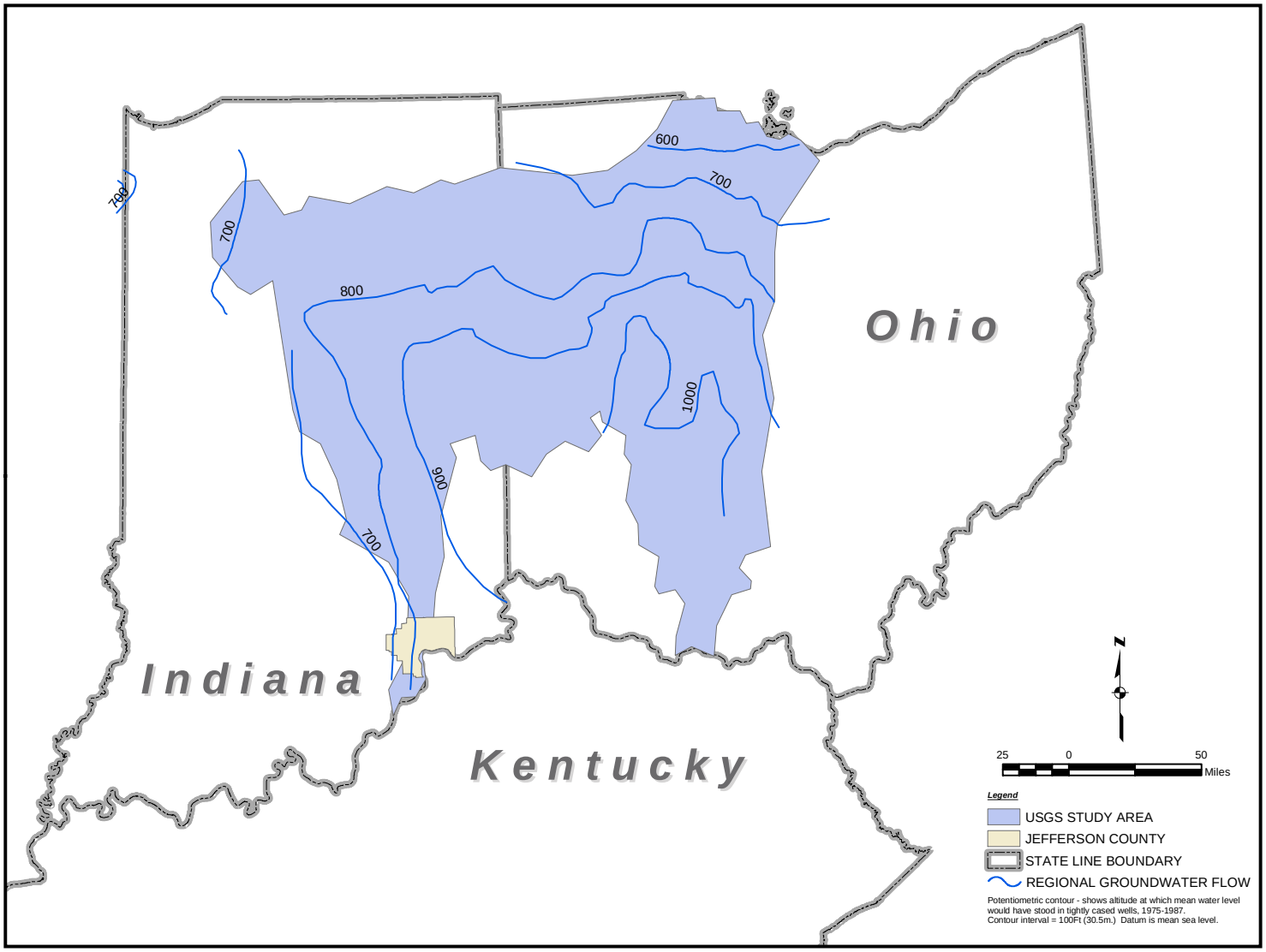
Well No.	Date Completed	Total Depth (ft)[a]	Depth to Bedrock (ft)[a]	Water Level Depth[b] (ft Below Ground Surface)	Comment
1	12/6/83	33.2	4.5	10	1.5 feet (ft) disturbed by detonation. Fire-granted gray limestone. Loss of recirculation water near 8 ft.
2	12/13/83	23.7	7	10	1.5 ft disturbed by detonation. Fractured gray to brownish-gray limestone. Loss of recirculation water near 14.8 ft. Large solution cavities and shaley-clay-filled voids.
3	12/13/83	4.3	18.5	8	1.5 ft disturbed by detonation.
4	12/14/83	28.5	10	3	
5	12/7/83	33.4	20.3	5.6	1 ft disturbed by detonation.
6	12/17/83	40	NA	18.25	1.5 ft disturbed by detonation. No bedrock encountered.
7	12/8/83	53.7	26.5	8.8	
8	12/9/83	28.2	14.5	23	Loss of recirculation water at 20 ft.
9	9/18/88	38.2	3.7	32	
10	9/18/88	41.3	NA	3	No bedrock encountered. Borehole encountered glacial till.
11	9/19/88	41.9	2	6.8	Limestone with horizontal solution features. Solution cavities filled with sediment.

Source: SEC Donahue, Inc. 1992.
[a]To convert feet to meters, multiply by 0.3.
[b]Groundwater levels from borehole drilling logs.
NA – not applicable.



Source: SEC Donahue, Inc. 1992.

Figure 2-8. Groundwater Contours of the DU Impact Area



Source: Bugliosi 1990.

Figure 2-9. Regional Groundwater Flow Direction for the Cincinnati Arch

2.6.2.3 Off-site groundwater wells

A review of the State of Indiana records of groundwater wells drilled off-site in a downgradient direction indicated that nine groundwater wells completed in bedrock had been drilled from 1945 to 1966 for domestic and stock use. Table 2-6 summarizes water wells identified by an online search of the Indiana Department of Natural Resources (IDNR) well data files. It is unknown if these wells currently are operational. The closest well location is approximately 4 miles (6.4 km) southwest of the DU Impact Area. The Draft Final RI provides additional information on wells in Jennings, Ripley, and Jefferson Counties (MWH 2002).

2.7 CULTURAL RESOURCES

Cultural resources at JPG have been investigated as part of either archaeological overviews or previous archeological surveys. A total of 153 sites have been recorded in 4,872 surveyed acres (19.7 km^2) [Geo-Marine 1996]. The majority of the identified sites are located in the cantonment area, located south of the firing line. Much of the installation, particularly the area north of the firing line (including the DU Impact Area), has had limited access and development during the last 50 years. However, because of its use as a proving ground, there has been loss of potential archaeological sites (Geo-Marine 1996).

Cultural resources at JPG are protected under two separate agreements. The 1992 Amended BRAC Programmatic Agreement between the Department of the Army, the ACHP, and the NCSHPO requires the Army to identify and evaluate historic properties, determine the effects of BRAC actions on historic properties, and take actions to ensure that the effects of BRAC actions on historic properties are in accordance with the agreements in the BRAC Programmatic Agreement. The MOA between the Army, the ACHP, and the Indiana SHPO stipulates that the Army implement a Cultural Resources Management Plan, among other requirements. The Cultural Resources Management Plan provides guidelines and procedures to enable JPG to meet its legal responsibilities while under Army control for the identification, evaluation, and treatment of historic properties under its jurisdiction (Geo-Marine 1996).

Six structures at the installation are on the NRHP, including the Oakdale School, Old Timbers Lodge, and four stone arch bridges over Otter Creek, Marble Creek, and Graham Creek (IDNR 1996). None of these sites is located within the DU Impact Area, as shown on Figure 2-10.

A cultural resources sensitivity model was developed for the installation that excludes a total area of 33,645 acres (136 km^2) of the site because either the land has been previously disturbed by construction, use, or maintenance of the facility, or the areas have been surveyed previously. The DU Impact Area falls into the excluded area both because portions of the land area have been disturbed to a depth greater than 6 ft (1.8 m) BGS and because of the presence of UXO. Although no cultural resources survey has been conducted at the DU Impact Area because of the UXO and DU hazards, 10 potential historic site locations were documented through research of historic maps and atlases between 1876 and 1921. These sites were determined to be in poor condition because of the extensive land disturbance and were determined to be ineligible for the NRHP (Geo-Marine 1996).

In 1994, a chert survey was conducted along the banks of Big Creek up to the western border of the DU Impact Area. One archeological site was found downstream from the DU Impact Area. The site was not eligible for listing on the NRHP (Geo-Marine 1996).